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2016 TILLAGE RADISH PLANTING DATE X SEEDING RATE TRIAL

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Farmers are interested in growing tillage radishes as they may potentially offer many environmental and economic benefits. Tillage radishes are quick at scavenging excess nitrogen (N), provide good ground cover, and break down very quickly in the spring to make way for spring planting. The plants winter kill, but the dead frozen plant material can still supress the earliest spring weeds from establishing. The roots themselves are known to drill through compacted soil layers as they grow, and the holes left by decomposed roots the next spring may also allow more water to infiltrate into the soil. Growing tillage radish as a cover crop in the northeast is new, and best practices for success have yet to be established. Although a tillage radish crop may have many benefits, it must be planted earlier than our other cereal grain cover crops commonly used following corn silage. Proper planting and seeding rates must be determined to enable the crop to provide quick ground cover and substantial root growth while minimizing planting costs. The goal of this project was to determine the impact of planting date and seeding rate on tillage radish survival and crop characteristics including N content and root volume. While the data presented are only representative of one year, this information can be combined with other research to aid in making planting decisions for tillage radishes in the Northeast.

MATERIALS AND METHODS

A trial was conducted at Borderview Research Farm in Alburgh, Vermont in 2016 to evaluate four tillage radish planting dates and four seeding rates. Agronomic information for the trial can be found in Table 1. The soil was a Benson rocky silt loam and the previous crop was spring wheat. Plots were prepared with fall chisel plow and disk, and finished with a spike tooth harrow. The experimental design was a randomized complete block with split plots replicated four times. The plot size was 5’x20’, and plots were seeded with a Great Plains cone seeder. The main plots were four planting dates (19-Aug, 29-Aug, 6-Sep, and 13-Sep). The subplots were four seeding rates: 3, 6, 9 and 12 lbs of viable seed per acre.

Table 1. Agronomic practices for the 2016 tillage planting date x seeding rate trial, Alburgh VT.

Location	Borderview Research Farm – Alburgh, VT
Soil type	Benson rocky silt loam 3-8% slope
Previous crop	Spring wheat
Tillage operations	Fall chisel plow, disk and spike tooth harrow
Seeding rate (lbs ac^{-1})	3, 6, 9, 12
Planting equipment	Great Plains cone seeder
Row width (in.)	6
Plot size (ft)	5 x 20
Planting dates	19-Aug, 29-Aug, 6-Sep, and 13-Sep
Variety	Groundhog
Harvest dates	8-Nov

Tillage radish biomass was measured on 8-Nov. All plants in a 0.5 m^2 quadrat from each plot were collected, and counted. Weights for the harvested material (root and vegetation) were recorded. Five plants were selected at random from each plot sample to record root diameter and length. Subsamples of vegetation and roots were weighed before and after drying to determine dry matter for each plot. After drying, roots and tops were combined and ground with a Wiley laboratory mill. The coarsely-ground plot samples were brought to the lab where they were reground using a cyclone sample mill (1mm screen) from the UDY Corporation. A subsample of each was retained for nitrogen analysis. The subsamples were analyzed for nitrogen content at the University of Vermont's Testing Laboratory in Burlington, VT.

All data was analyzed using a mixed model analysis where replicates were considered random effects. The LSD procedure was used to separate means when the F-test was significant ($P < 0.10$).

Variations in yield and quality can occur because of variations in genetics, soil, weather, and other growing conditions. Statistical analysis makes it possible to determine whether a difference among treatments is real or whether it might have occurred due to other variations in the field. All data was analyzed using a mixed model analysis where replicates were considered random effects. At the bottom of each table a Least Significant Difference (LSD) value is presented for each variable (e.g. yield). LSDs at the 10% level (0.10) of probability are shown. Where the difference between two treatments within a column is equal to or greater than the LSD value at the bottom of the column, you can be sure in 9 out of 10 chances that there is a real difference between the two values. In the example below, treatment A is significantly different from treatment C but not from treatment B. The difference between A and B is equal to 200, which is less than the LSD value of 300. This means that these treatments did not differ in yield. The difference between A and C is equal to 400, which is greater than the LSD value of 300. This means that the yields of these two treatments were significantly different from one another. The treatment in bold had the top observed performance, while treatments with an asterisk did not differ significantly from the top performer.

Planting date	**Yield**
A	**2100***
B	1900*
C	1700
LSD (0.10)	300

RESULTS

Weather data collected with an onsite Davis Instruments Vantage Pro2 Weather Station at Borderview Research Farm in Alburgh, VT, are summarized for the 2016 tillage radish growing season (Table 2). August, September, and October were all warmer than the historical average (1981-2010). The warm fall overall resulted in 239 more growing degree days than the 30-year average, as calculated with a base temperature of 41°F. The 2016 fall growing season was slightly more dry than average, with 0.71 fewer inches of rain than normal between August and October.

Table 2. Summarized weather data for fall 2016, Alburgh, VT.

Alburgh, VT	August	September	October
Average temperature (°F)	71.6	63.4	50.0
Departure from normal	2.9	2.9	1.9
Precipitation (inches)	3.00	2.50	5.00
Departure from normal	-0.93	-1.17	1.39
Growing Degree Days (base 41°F)	942	681	320
Departure from normal	82	95	62

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger.
Historical averages are for 30 years of NOAA data (1981-2010) from Burlington, VT.

Impact of Planting Date

Table 3. Tillage radish dry matter yields by planting date, Alburgh, VT, 2016.

Planting Date	Whole plant nitrogen yield lbs ac^{-1}	Vegetation dry matter yield lbs ac^{-1}	Root dry matter yield lbs ac^{-1}	Total dry matter yield lbs ac^{-1}
19-Aug	**161**	**3446**	**1928**	**5382**
29-Aug	133	2964*	1239	4174
6-Sep	86	1978	423	2393
13-Sep	51	1197	114	1279
LSD (0.10)	21	486	307	581
Trial mean	108	2397	926	3307

Treatments indicated in **bold** had the top observed performance.
* Treatments that did not perform significantly lower than the top performer.

Earlier planting dates resulted in higher yields across all categories this year. The earliest planting date, 19-Aug, resulted in the highest whole plant nitrogen yield (161 lbs ac^{-1}), vegetation dry matter yield per acre (3446 lbs ac^{-1}), root dry matter yield per acre (1928 lbs ac^{-1}), and total dry matter yield per acre (5382 lbs ac^{-1}) (Table 3). The differences were significant in all categories. In vegetation dry matter yield, 29-Aug, the second planting date performed statistically similar to the first planting date, the leading performer. Otherwise all later planting dates performed significantly lower than the planting date before it. The last planting date (13-Sep) was the lowest performer in all categories.

Table 4. Tillage radish root length and diameter by planting date, Alburgh, VT, 2016.

Planting date	Root length	Root diameter
	cm	in
19-Aug	**24.0***	**2.13***
29-Aug	23.1*	1.55
6-Sep	18.6	0.72
13-Sep	15.4	0.41
LSD (0.10)	2.39	0.34
Trial mean	20.3	1.20

Treatments indicated in **bold** had the top observed performance.
* Treatments that did not perform significantly lower than the top performer.

Root length and root diameter both corresponded as expected in regard to the planting date (Table 4). The earlier the planting date, the larger the roots were. The differences between planting dates was significant. For Root length the (29-Aug) planting date (23.1 cm) was statistically similar to the (19-Aug) planting date (24.0 cm), the leading performer. The latest planting date (13-Sep) performed the worst in both categories.

Impact of Seeding Rate

Table 5. Tillage radish dry matter yields by seeding rate, Alburgh, VT, 2016.

Seeding Rate	Whole plant nitrogen yield	Vegetation dry matter yield	Root dry matter yield	Total dry matter yield
lbs ac^{-1}	lbs ac^{-1}	lbs ac^{-1}	lbs ac^{-1}	lbs ac^{-1}
3	99	2017	**1139**	3142
6	102	2251	797	3009
9	**118**	**2738***	966	**3684**
12	112	2581*	802	3392
LSD (0.10)	NS	487	NS	NS
Trial mean	108	2397	926	3307

Treatments indicated in **bold** had the top observed performance.
LSD – Least significant difference.
NS – No significant difference.

The only significant difference in terms of yield in regard to seeding rate was the vegetation dry matter yield (Table 5). The 9 lbs ac^{-1} rate had the highest yield (2738 lbs ac^{-1}) and was statistically similar to the 12 lbs ac^{-1} yield (2581 lbs ac^{-1}). Whole plant nitrogen yield, root dry matter yield, and total dry matter yield were statistically similar between the seeding rates.

Table 6. Root length and root diameter by seeding rate, Alburgh, VT, 2016.

Seeding rate lbs/ac^{-1}	Root length cm	Root diameter In
3	**21.7***	**1.70***
6	20.4*	1.01
9	21.2*	1.32
12	17.8	0.79
LSD (0.10)	2.39	0.37
Trial mean	20.3	1.20

Treatments indicated in **bold** had the top observed performance.
LSD – Least significant difference.

There was a significant difference between the seeding rates for root length and root diameter (Table 6). The 3 lbs ac^{-1} rate was the top performer for both length (21.7 cm) and diameter (1.70 in). The 6 lbs ac^{-1} and 9 lbs ac^{-1} rates were statistically similar to the top performer for root length. The 12 lbs ac^{-1} seeding rate performed the worst in both categories.

Planting Date by Seeding Rate Interactions

The only significant interactions between tillage radish planting dates and seeding rates affected root length and root diameter (Figures 1 and 2). In terms of biomass yield or nitrogen scavenging, seeding rate does not need to be modified regardless of planting date. However, if the primary goal is root length or diameter, lower seeding rates might be more beneficial for earlier planting dates to provide optimal growth.

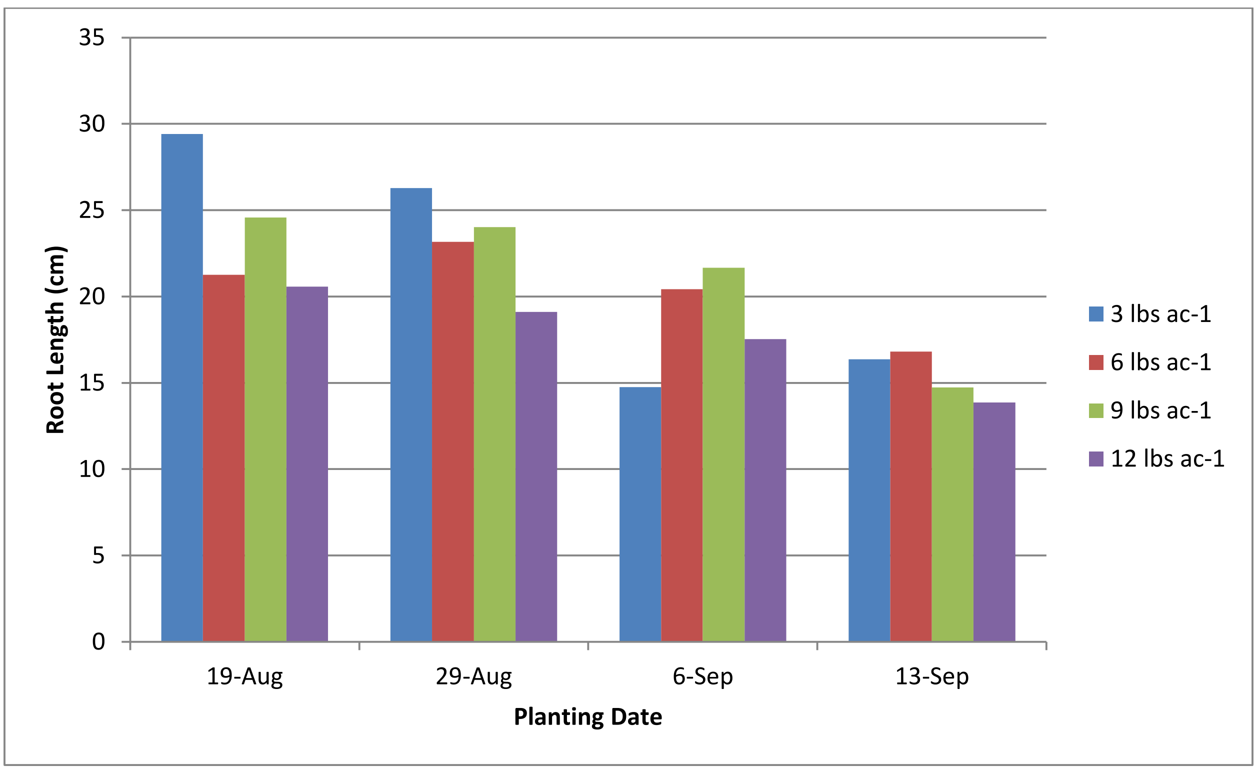

Figure 1. Root length (cm) by planting date for four seeding rates.

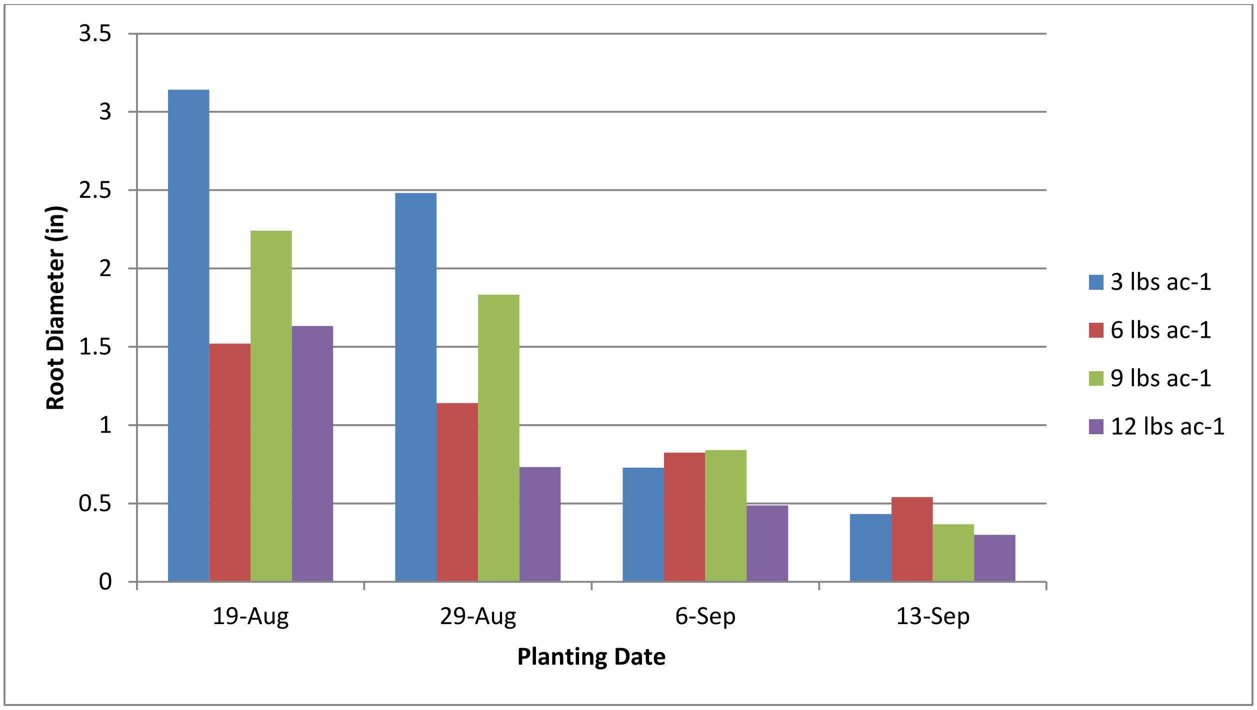

Figure 2. Root diameter (in) by planting date for four seeding rates.

DISCUSSION

On average, tillage radishes produced 3307 lbs of dry matter per acre and were able to scavenge 108 lbs of nitrogen per acre from the soil. These results were greater than the trial averages from the 2015 trials (1575 lbs of dry matter per acre and 36.3 lbs of nitrogen per acre) and 2014 trials (1573 lbs of dry matter and 40.4 lbs of nitrogen per acre).

The planting date results suggest that planting tillage radishes before the end of August will improve biomass yields, nitrogen retention, and root size compared to planting by the middle of September.

In this study, seeding rate did not significantly impact nitrogen retention. In terms of yield, seeding rate significantly impacted the above-ground biomass, with the 9 lbs ac^{-1} seeding rate, yielding the most, similar to the 12 lbs ac^{-1} rate. Below ground biomass and total plant biomass were not significantly different between seeding rates. The current recommended seeding rate provided by most seed companies is 6 to 8 lbs of tillage radish seed per acre. In terms of root length and diameter the lowest seeding rate of 3 lbs ac^{-1} performed the best. This seeding rate and the 6 lbs ac^{-1} rate performed comparably or better to the higher rate of 12 lbs ac^{-1} in terms of root size, nitrogen retention, and total biomass. Based on this data, the lower seeding rates of 6 lbs per acre or 3 lbs ac^{-1} are adequate to accomplish the nitrogen retention goals that most farmers are hoping to achieve when planting this cover crop.

These data in this study represent only one year and should not alone be used to make management decisions.

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